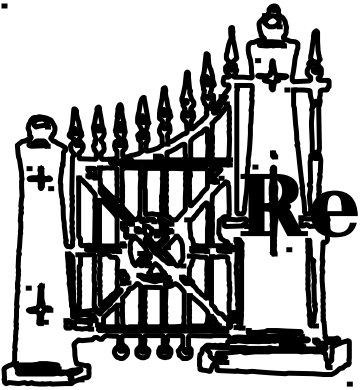
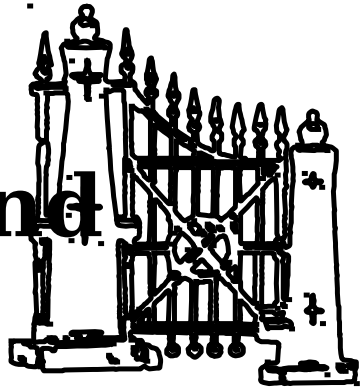
ARDEC



Ammunition Packaging Recent Accomplishments and Future Thrusts

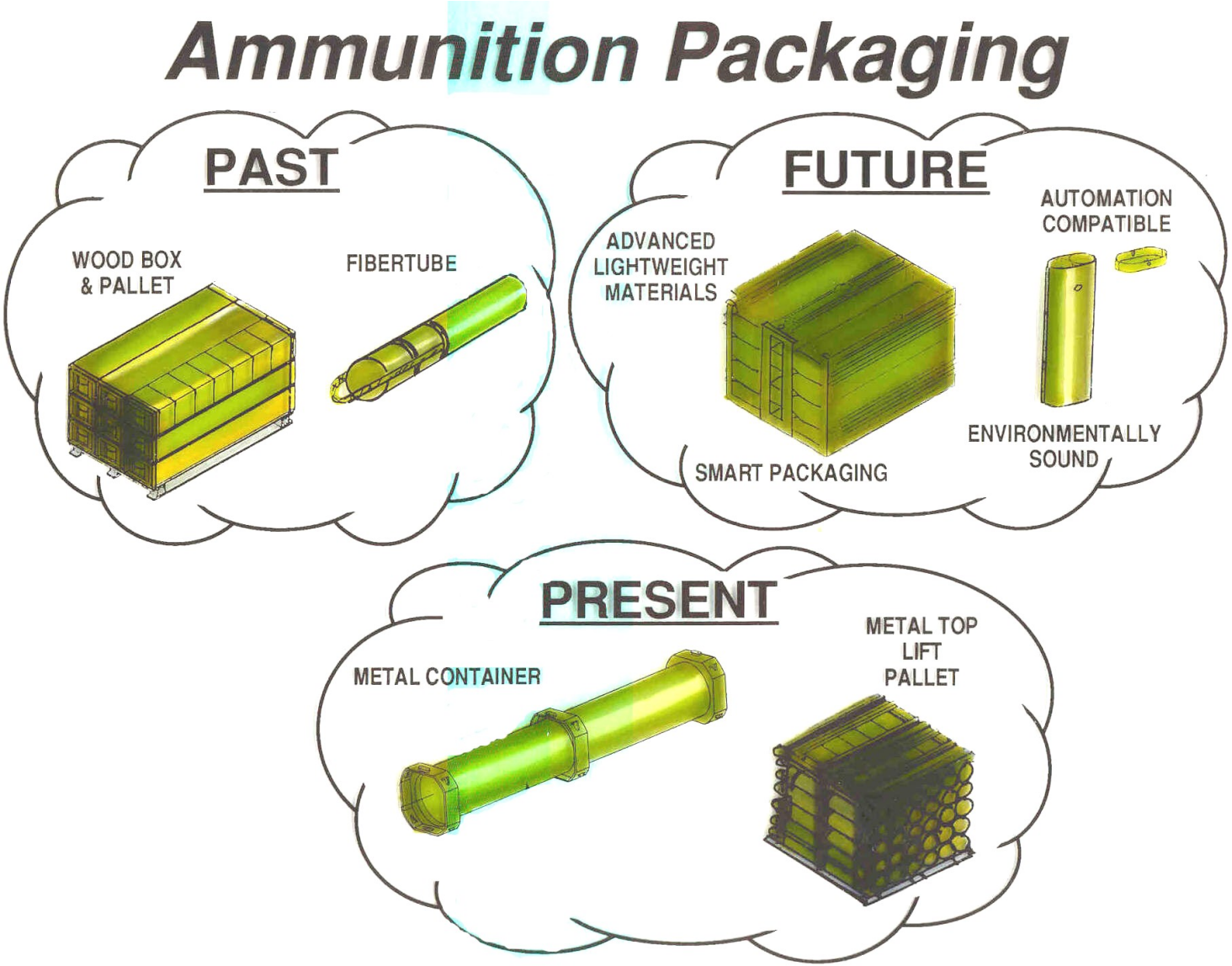


James F. Zoll/Al Galonski/Mil
Selk
Logistics Research and Engineering Directorate

Greg Willis
Defense Ammunition Center

AMMUNITION PACKAGING

Outline



AMMUNITION PACKAGING

ARDEC Packaging Design and Engineering Group

Has Design and Development Responsibilities for Ammunition Packaging
Most Conventional Ammunition Items for Army and Single-Manager Ite

> PRIMARY CUSTOMER PEO AMMO

TRADITIONALPACKAGING DESIGN PHILOSOPHY

- U.S. Army Packaging Is Designed to Deliver Safe and Reliable Ammunition Under All Adverse Conditions
  - 20 Years Storage Life (Two Years Outdoor)
  - Severe Rough Handling at Temperature Extremes
  - NBC Decontaminable (3 psi Sealing Ability)
- Meets Rigorous User Requirements
  - Interfaces With Soldiers, Vehicles and Weapons
  - Easy Opening/Man Portable
  - Facilitate Rapid Resupply and ReArm

PACKAGING FOR THE FUTURE ARMY

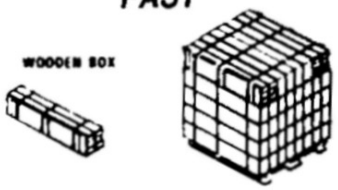
- Design to Minimize Packaging and Maximize Ammo per MHE and Airlift
  - CONUS Based Force – Air Resupply Vital
- Safely Pack and Ship More Ammo and Different Types of Ammo Together
  - Must Meet Insensitive Munitions Criteria
- Facilitate Rapid Resupply and Automatic ReArm– Compatible with Future Automated Systems – FCS
- NO LOSS IN PROTECTIVE ABILITY DESPITE MINIMAL PACKAGING
  - Cold War “Iron Mountain” of Ammo No Longer Viable
  - Precision Weapons – Less Ammo/More Value per Item

Packaging is not just a BOX…
But a Proven Combat Multiplier

PACKAGING ... A PROVEN COMBAT MULTIPLIER

120MM, M829/M830 TANK CARTRIDGE CONTAINER

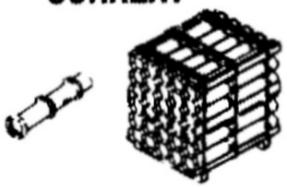
PAST



SHORTCOMINGS

- HEAVY
- NOT NBC DECONTAMINABLE
- HIGH CUBE
- NOT USER FRIENDLY
- COMPATIBILITY WITH RESUPPLY

CURRENT



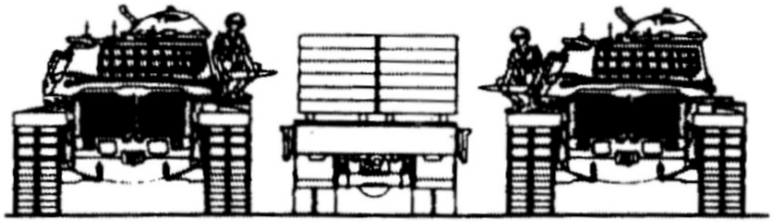
BENEFITS

- REDUCED WEIGHT 10%
- NBC DECONTAMINABLE
- 50% INCREASE IN ROUNDS/PALLET
- USER FRIENDLY
- DECREASED REARM TIMES

OBJECTIVES:

- REDUCE CUBE, WEIGHT AND COST OF AMMUNITION LOGISTICS
- REDUCE REARM TIMES AND MAINTENANCE COSTS
- NBC DECONTAMINABLE
- PROVIDE A TOP LIFT CAPABILITY

120MM AMMUNITION TANK UPLOAD CONCEPT ONE OR TWO TANKS AT A TIME



PAST SYSTEM

REQUIRES 33 Min

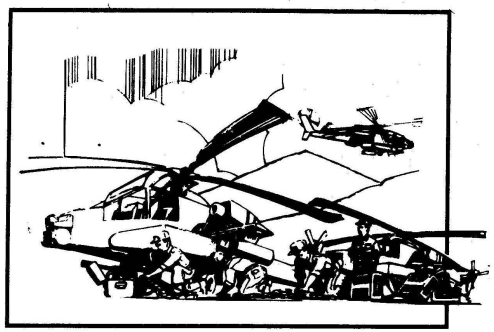
LOAD 34 RDS

REPACKAGING

Current Container 14 Min

PACKAGING ... A PROVEN COMBAT MULTIPLIER

11.D.10 LOGISTICS REARM



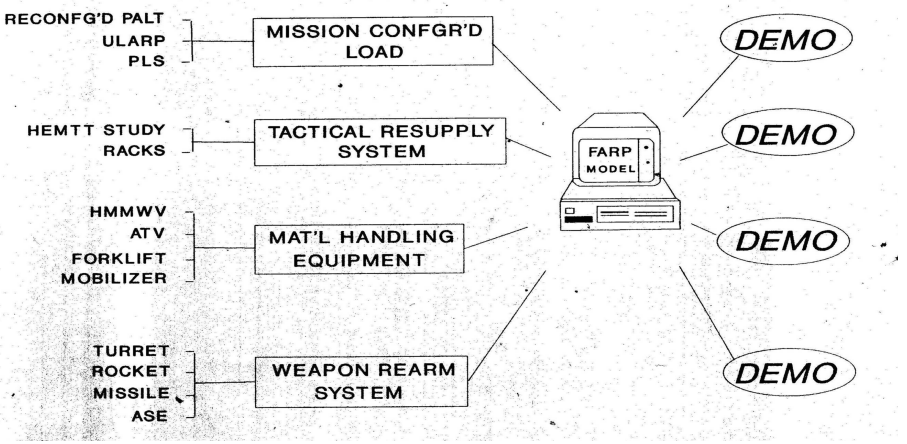
ATTACK HELICOPTER LOGISTICS

DEMONSTRATE BY FY 96, MEANS OF CONDUCTING RAPID AND REPEATED ATTACK HELICOPTER (APACHE/COMMANCHE) REARM OPERATIONS IN HOSTILE (UNPREPARED FARP's, & NBC) ENVIRONMENTS THROUGH IMPROVED MATERIAL HANDLING EQUIPMENT, VEHICLES AND COMBAT CONFIGURE LOADS THAT WOULD REDUCE REARM MANPOWER REQUIREMENTS BY UP TO 60%

FY 91-96 ARDEC STO

Total System Approa

- **Logistics System**
  - **Packaging**
  - **Handling**
  - **Storage**
  - **Transportation**
- **Weapon System**



REARM

(Apache 30mm Area Weapon Sy

Current Method:

- 2-3 Man Operation
- Needs Loader /Downloader
- Unfavorable Loading Positio

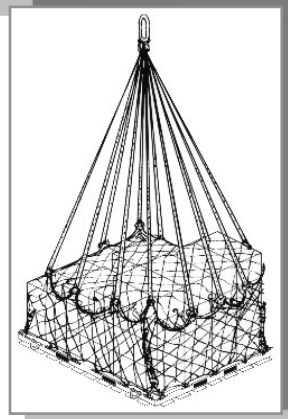
Longbow Sideloader

- 1 Man Operation
- On-Board System
- Favorable Loading Position
- 50% Faster Operation
- 14 Min Total Rearm Time
- Implemented On Longbow 3Q98

RESUPPLY

Current Method:

- Manpower Intensive
- Prolonged FARP Setup Times



Future Method:

- *FASTPACK* Packaging
- Mission Configured Loads
- Intermodal

AMMUNITION PACKAGING

Traditional Ammunition Packaging

- Prior to 1983 basically WWII Technology
- Primarily Wood Box/Fiber Tube
- Designed for Log System not Soldier
- Heavy, Bulky and often Ineffective
- Large percentage of existing inventory in old packaging

This style Packaging is <u>Still</u> the image in Army & AMC

The deficiencies of this
Packaging has spawned
The current sealed met
Containers.

AMMUNITION PACKAGING

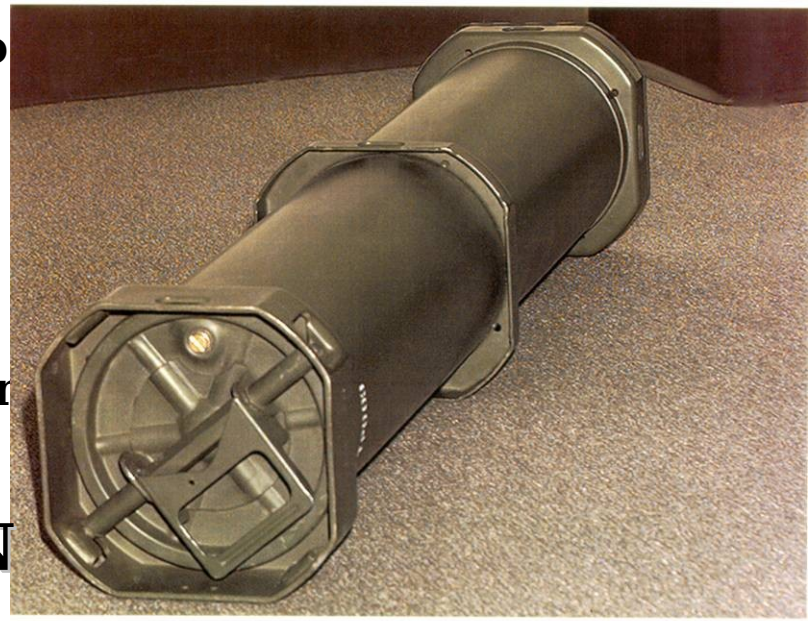
Present Ammunition Packaging For the Legacy Force

U.S. AMMUNITION PACKAGING

FAMILY OF STEEL CYLINDRICAL CONTAINERS FOR LARGE MUNITION ITEMS

- **Cylindrical Containers Provide for Rapid Access to Ammunition while still Palletized on Improved Metal Pallets**
- **Provides Maximum Protection for Sensitive Smart Munitions**
- **Family of Cylindrical Containers:**
  - **PA116: 120MM Tank Ammo**
  - **CNU553: TOW Missile**
  - **PA117 : 105MM Tank & Artillery Ammo**
  - **PA113: Volcano Munitions**
  - **PA160: WAM Mine Munition**
  - **PA158: Stinger Missile**

MAXIMUM PROTECTION



AMMUNITION PACKAGING

Present Ammunition Packaging For the Legacy Force

U.S. AMMUNITION PACKAGING

FAMILY OF STEEL RECTANGULAR CONTAINERS FOR SMALL ARMS AND MORTAR AMMUNITION ITEMS

- Rectangular Steel Boxes Provide Sealed Environment, Protect Ammo from Damage and Serve as Firing Boxes
- ARDEC Manages two families of Metal Containers
- Hinged Cover (M2A1 Family):
  - PA108: 5.56MM SAW Ammo
  - M2A1: .50 Cal, 5.56MM
  - M19A1: 7.62MM Ammo
  - PA70: 60MM Mortar Ammo
- Fully Removable Cover (M548 Family):
  - PA120: 40MM Ammo
  - M548: 20MM, 40MM, 7.62MM Signal Flares and Fuzes
  - PA125: 25MM Ammo
  - M592: 30MM Ammo
  - PA156/157: 81MM Mortar Ammo
  - PA154: 120MM Mortar Ammo

AMMUNITION PACKAGING
Packaging Initiatives – Available

New Developments allow for the Incorporation of Recent Require
A Comprehensive Design Solution

Key Design Features

Roto-lining

- Seals All Potential Container Leak Paths
- Enhances Resilience of the Tube Wall
- Forms a Durable Permanent Bond Between Aluminum and Plastic

Closure Mechanism

- Provides Rapid Access to Contents
- Isolated from Direct Impact

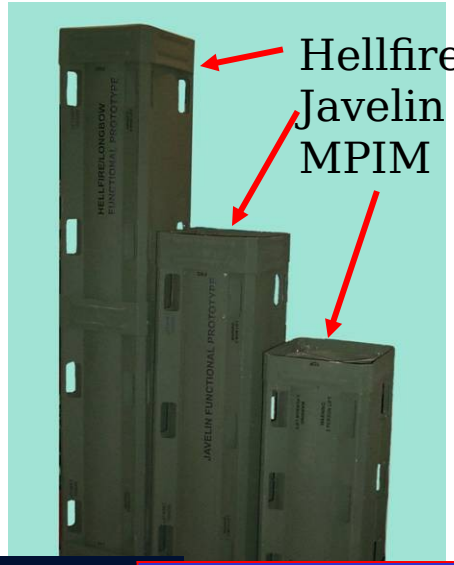
Container Structure

- Utilizes Simple Structural Component
- "Gussets" Provide Longitudinal Streng
- "Stack Towers" Provide Stacking Stre
- In Combination, Provide Protection fo Latching Mechanism

Benefits

Minimal Tooling
Reduced Number of Parts
Insensitive Munitions "Friendly"
Rapid Prototyping
Scaleable

PRODUCTION COST 25% LESS THAN COMPARABLE CURRENT PACKAGING

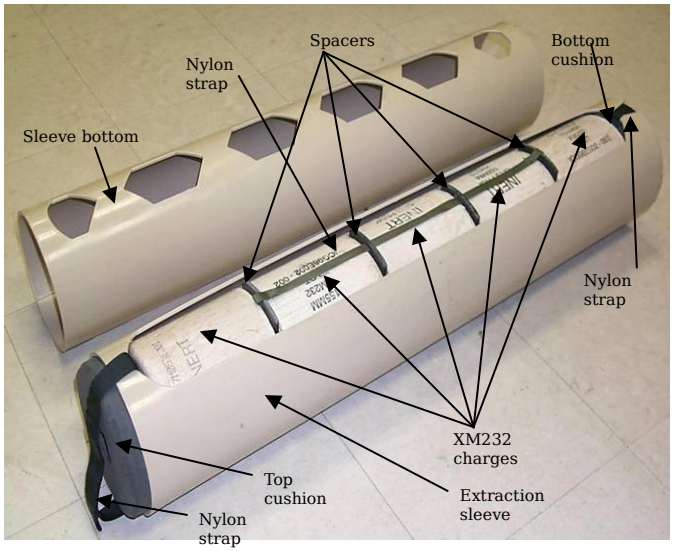


NIPHLE
Award Winner
2001 "Long-life"

Pressure Vents as Part Of the Design

AMMUNITION PACKAGING
Packaging Initiatives – Current

Packaging Enhancements to help items meet Insensitive Munitions (IM) requirements



Packaging System for M231/XM232 Modular Propelling Charge

- Thermoplastic Ionomer Contains 40% Fiberglass
- Melts @ 260 F
- Successfully Passed FCO, and Transportation/Rough Handling Environmental Testing at Extreme Temperatures

PA161 (M231) and PA 103E2 are now in full production

Safer Container in Soldier's Hands Today!

AMMUNITION PACKAGING

Packaging Initiatives – Current

120MM CTG M829A2/E3

TO BE FIELDED WITH THE MATERIAL RELEASE OF THE 120MM M829A3 APFSDS-T CARTIDGE IN JUNE 2004

Fast Cook-off Test Set-up

Slow Cook-off Test Set-up

Vent size and location are critical to obtain desired results

Container Vents opened and containers remained intact. Reaction significantly reduced.

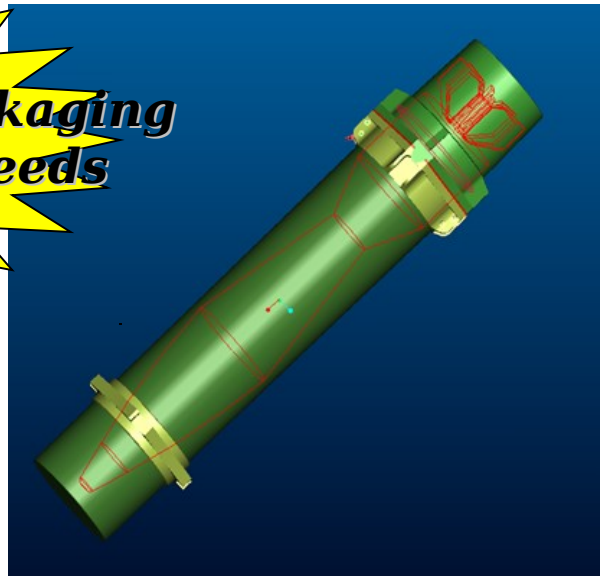
COMPOSITE MONOPACK FOR 120MM MORTAR AMMUNITION

Benefits

- **Monopack**
- **Eliminates packaging layers**
- **Very Light Weight – 8 lb**
- **Easy to Stack/Store**
- **Fit in Mortar Carrier**
- **Better Protection**
- **IM Characterisitcs**
- **Environment Friendly**

Current Packaging

Transforming Packaging To Meet Future Needs



ENTERING TESTING AND

PRODUCTION IN FY04

LRED Inititative Transitioned to and Funded by PM MORTARS

AMMUNITION PACKAGING
Packaging Initiatives - Future

Blast Box

Objective:

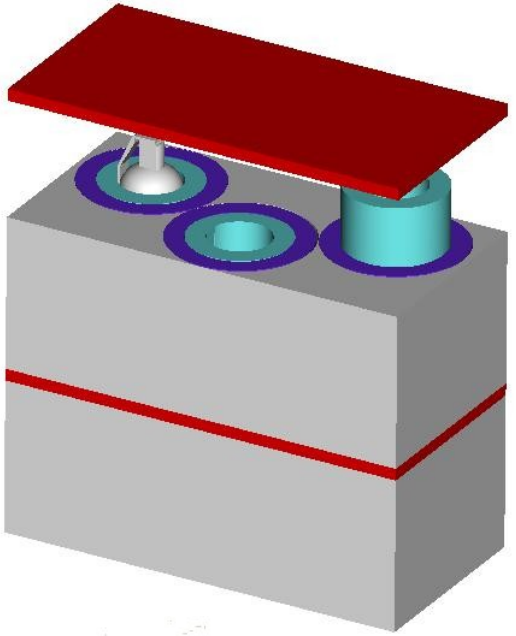
Provide a Container that will mitigate fragmentation due to unplanned stimulus

May allow traditionally incompatible materials to be shipped and stored with nearly all other ammunition.

Could provide another packaging “tool” as an IM solution for items with SD issues.

Configured Load Enabler

Benefits



Patent Pending

RESUPPLY PROBLEM - PAST

Lash Conversion

Barge dunnage for disposal

- **Breakbulk shipment standard until early 1990's**
- **Labor intensive, time consuming**
- **Not conducive to port through-put**
- **Required massive theater stockage buildup**
- **Diametrically opposes *"Army Transformation"* and *"Just In Time Logistics"***

Unacceptable Future Resupply

RESUPPLY INITIATIVE - PRESENT

- **PREPO conversion from breakbulk to ISO container / CROP / SCL**
- **Increased distribution velocity and port through-put**
- **Supports "Just In Time Logistics"**
- **Assists theater ordnance company responsiveness and through-put**
- **Enhances ammo survivability**
- **Reduces handling times; minimizes wooden dunnage**
- **Implements complete round concept**

PARTIAL PALLET EVALUATION

V-STF

Collapsible Wire Mesh

Breakdown Wood Bin

Collapsible Aluminum

Collapsible Aluminum

Grate Pallet

Half-high Wire Mesh

Collapsible Steel Corrugated

Rigid Wire Mesh

M-STF

Collapsible Wire Mesh

Joint effort with Logistics Research and Engineering Directorate

- **Possible use for retrograde/configured loads**
- **Study showed very few commercial containers could handle 2,000 lb ammo load**

COMMERCIAL CONSOLIDATORS

- Modular Concepts / Eliminate Overpacks
- Intermodal Conveyance Transport
- Adjustable / Re-configurable Interiors

Storage & Transport Frame (STF)

Field Pack-Up Containers (FPU

STEEL BLOCKING SYSTEM

- Reusable and adjustable
- Fits variety of loads / items
- Accountable item, costly
- Replaces majority of wood
- Long term use
- Limited pre-fab of wood assemblies

CASCOM
DCD-CSS

Smart Distribution

Logistics Research Engineering Directorate LRED

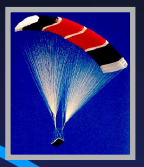
AMERICA'S ARSENAL FOR THE BRAVE

Configured Loads

STRATEGIC DISTRIBUTION PLATFORM

FTTS unloads Intermodal Platform at aerial port of debarkation

INTERMEDIATE STAGING BASE

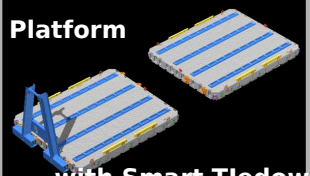


AREA OF OPERATIONS

Sustainment Modules delivered to FCS

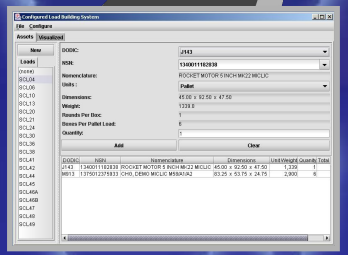
Sustainment Modules Configured in CONUS

Intermodal Modular Platform



with Smart Tiedown

Configured Load Building Tool to adjust to changing missions



Final adjustments to configuration

- Responsive support over extended distances
- Rapid transitions between transportation modes
- Limited, efficient reconfiguration
- Tailored loads for ease of reception

JOINT INTERMODAL LOGISTICS WORKING GROUP (JILWG)

Problem Statement

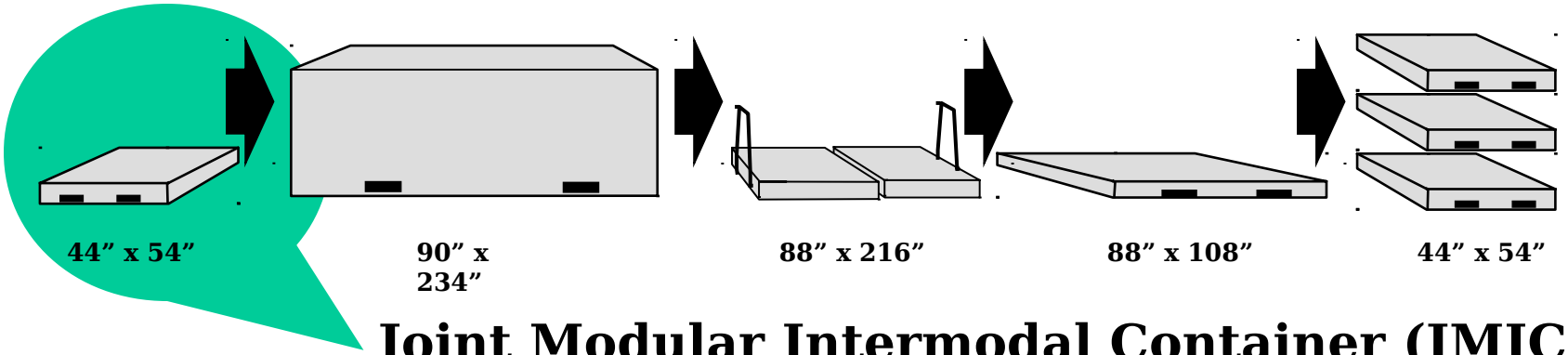
"The current logistics approach does not optimize the distribution system, support interoperability, minimize manpower or material handling and logistics footprint requirements."

Developing a Joint Service "Building Block" for ALL Classes of Supply

JILWG
INTERMODAL MODULAR PLATFORM

¼ - 463L Pallet Size - 88” x 108”

44” x 54” x 46” Interconnectable Modular Platform *into* **An ISO Container Shipping Load (Stackable)** *into* **Modular Intermodal Platform** *into* **An Aircraft 463L Pallet Load** *into* **A Unit Distribution Unit Load to the User**



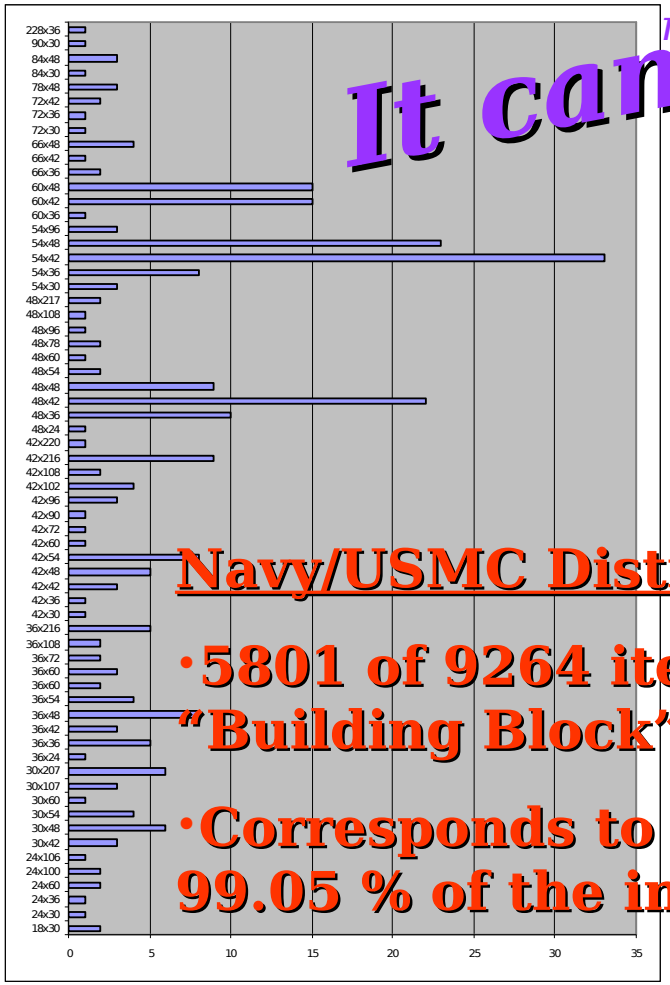
Joint Modular Intermodal Container (JMIC)

Status:

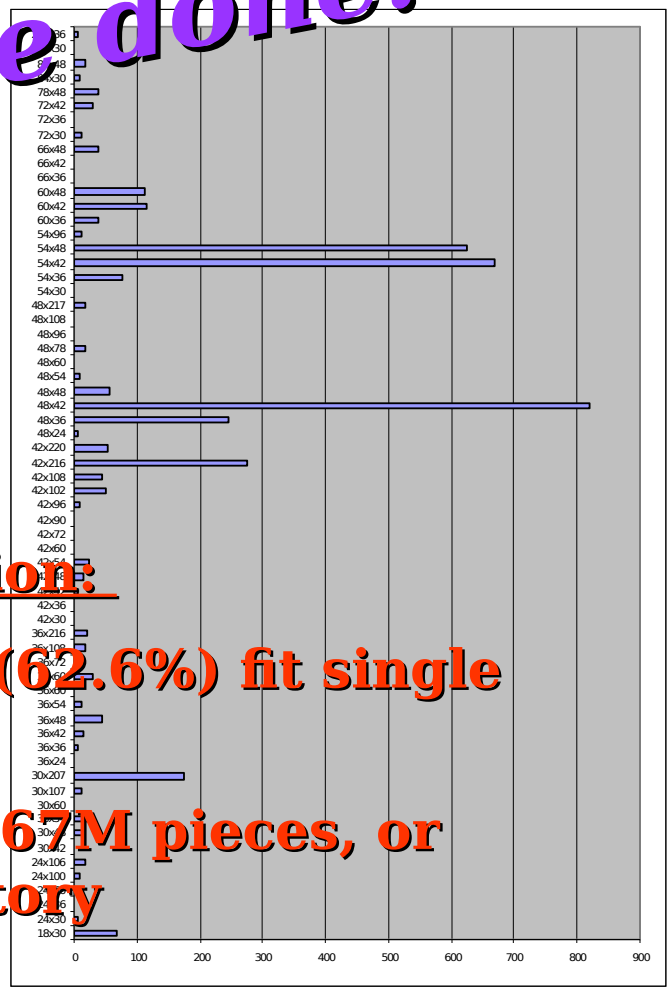
- Concept paper developed
- Working with TRANSCOM & JFCOM to enter FLOW exercises

JMIC
Preliminary Fit Analysis

*Army Class V Interval Platform Size Distribution – Platforms**



*Army Class V Interval Platform Size Distribution – DODICs**



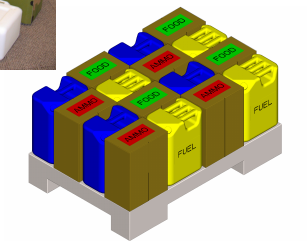
It can be done!

Navy/USMC Distibution:

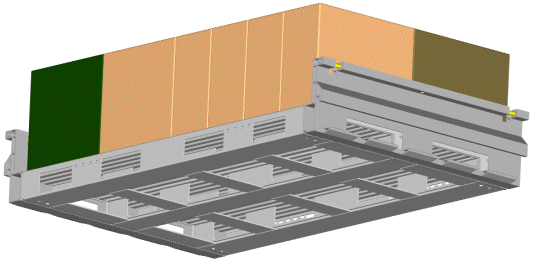
- **5801 of 9264 items (62.6%) fit single "Building Block"**
- **Corresponds to 465.67M pieces, or 99.05 % of the inventory**

* All dimensions given in inches (wxlxh)

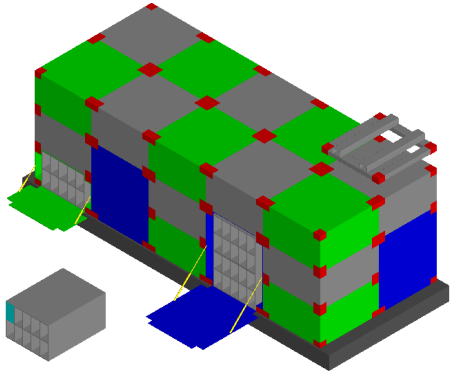
JILWG/JMIC – CONCEPTS



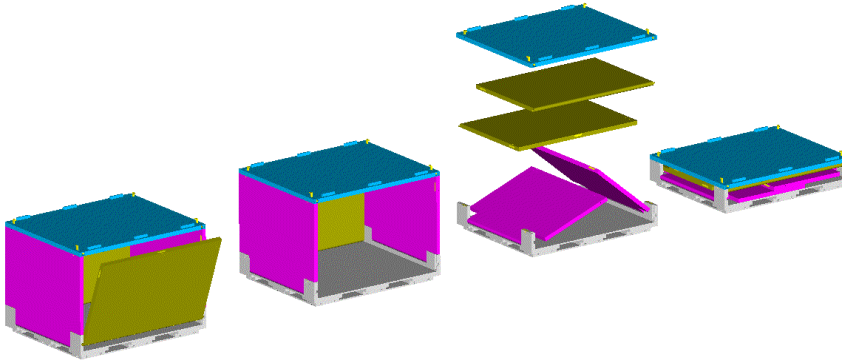
Disposable Packs
Unit Load of CLs



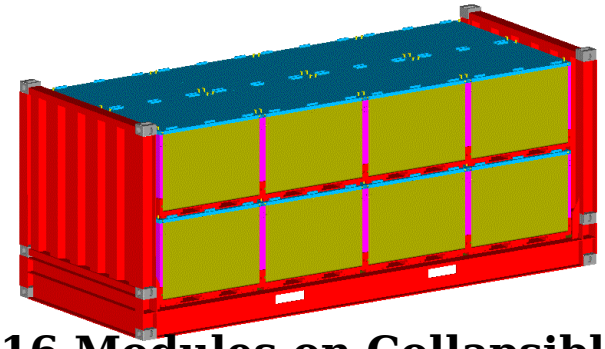
Intermodal Pallet



Modular Ammunition Ready Rack Sy



Collapsible Module



16 Modules on Collapsible 20’
ISO Container

JILWG/JMIC DEVELOPMENT
Army Sustainment Modules

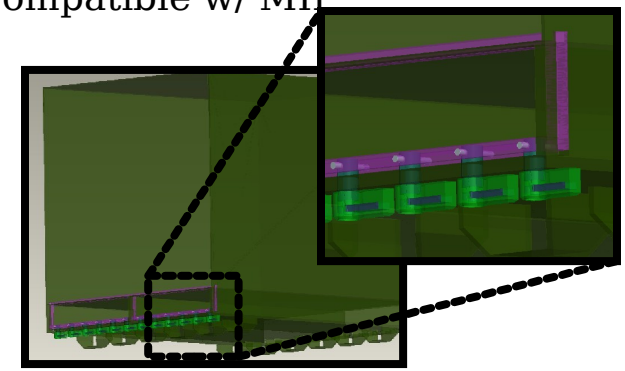
Gen 1 – Short Term: 1 Year

Used by MC
Nearly eliminates Blocking and Bracing
Significantly reduces banding

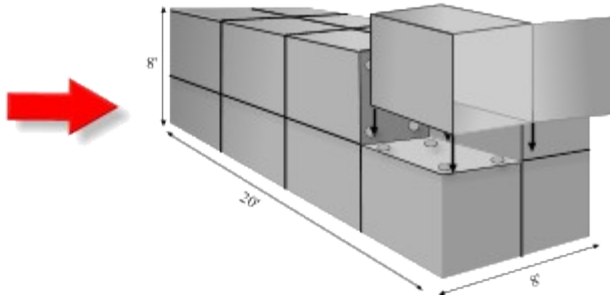
Gen 2 – Mid Term: 2-5 Years

Attributes of Gen 1 Plus

- Automatic Locking and Unlocking to New Pla
  Needed for Automatic Rearm
- Manual Side to Side Locks –eliminates bandi
- Compatible w/ MIP



Gen 3 – Long Term: 5-7 Years

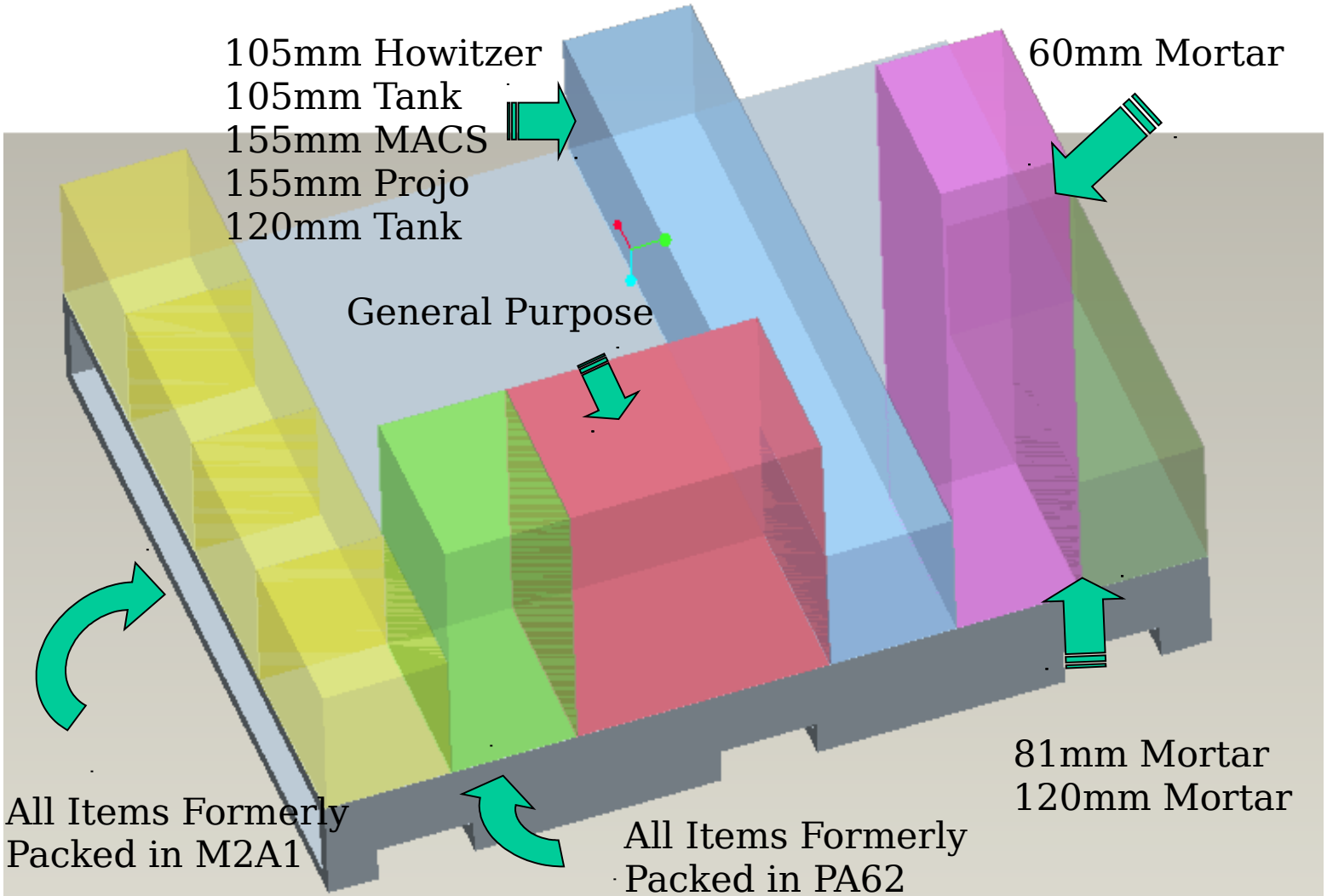


Ultimate Goal

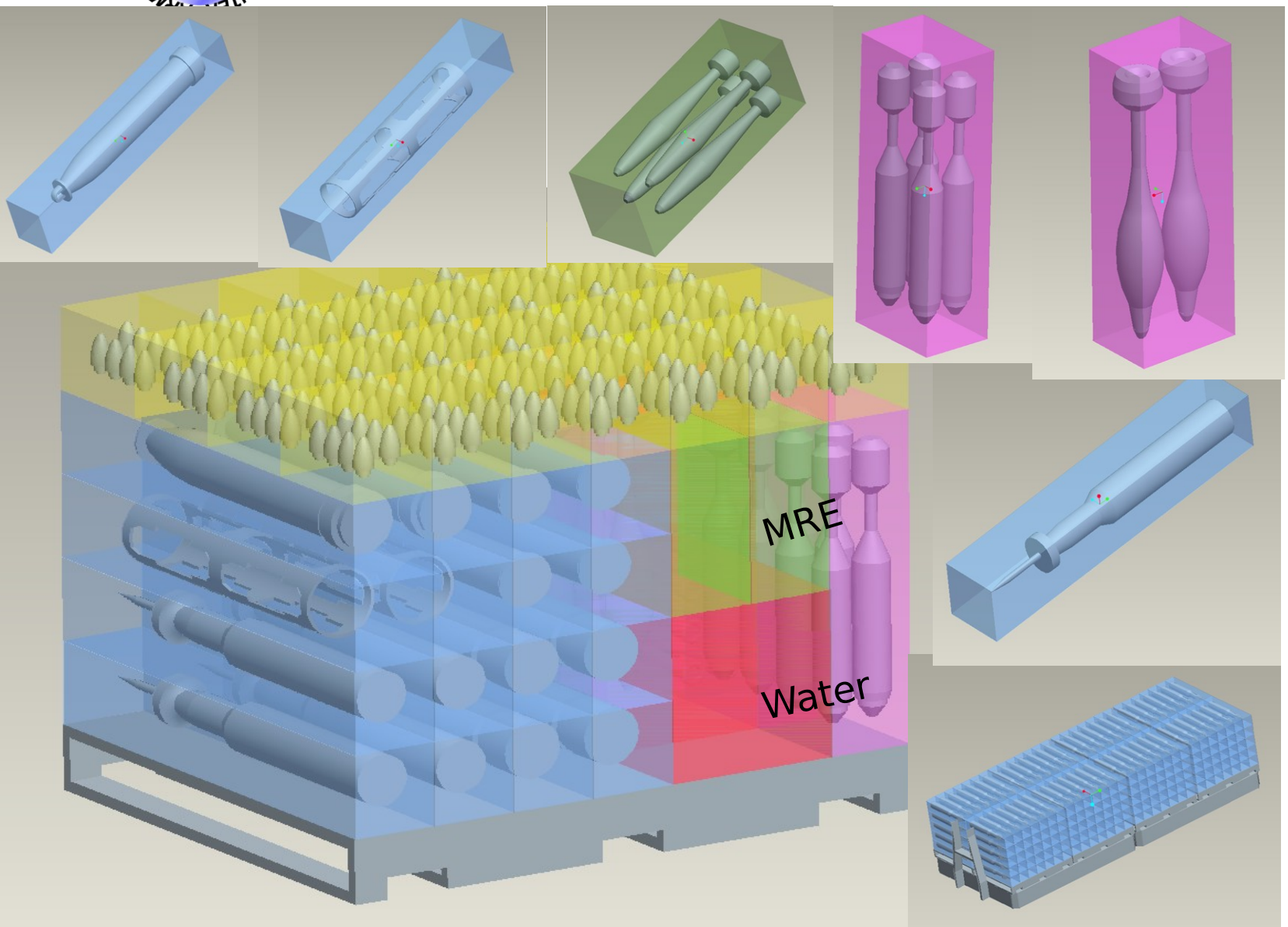
- No blocking and bracing
- Platforms not required
- Collapsible
- Fully Commercially Compatibl
- Supports all DOD visions
  FCS deployments
  Seabasing

PACKAGING INITIATIVES - FUTURE

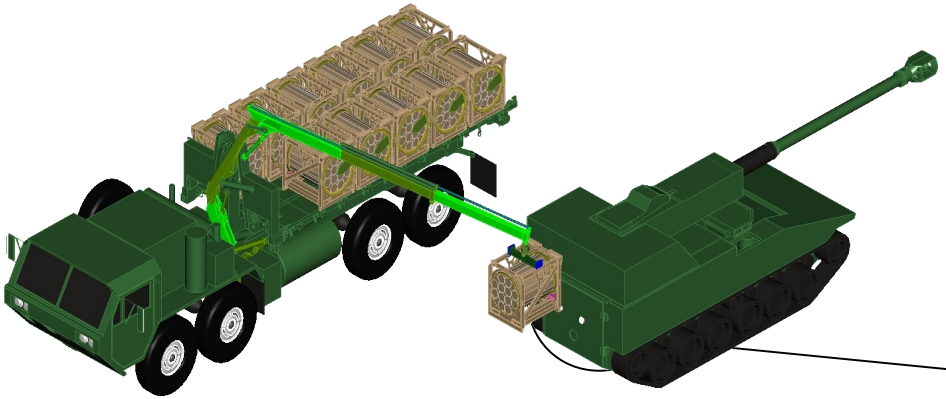
Modular Packaging -

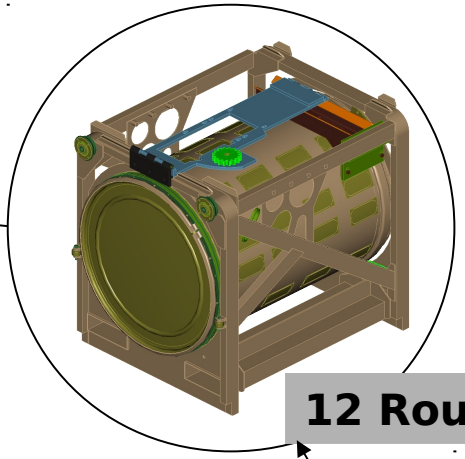


PACKAGING INITIATIVES - FUTURE
Modular Packaging

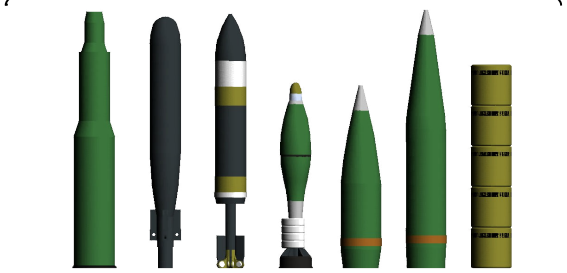


LOS, NLOS, BLOS MULTI ROLE
Resupply Concept





12 Round Clip



- Maintain common Rearm interface to LOS and NLOS-M
- Low Cost, Light Weight Packaging (Clips and Pallets)
- Handle LOS, Mortar, and Artillery Projectiles and Propellants
- Successfully Pass Drop and Vibration Tests for Fuzed Ammunition

Resupply Concept for all FCS Ground Vehicles

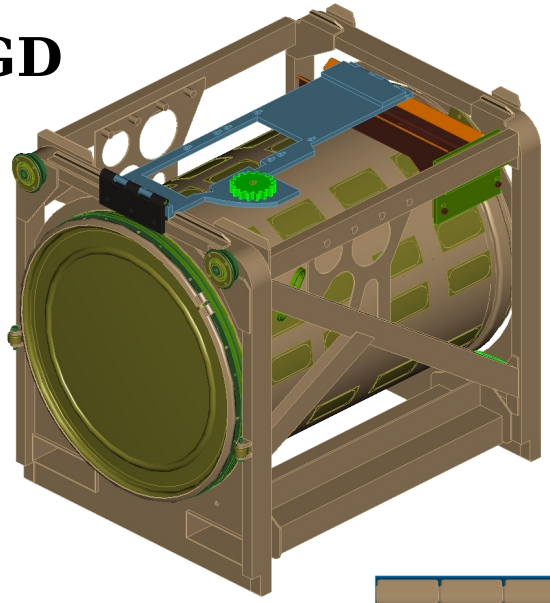
FUTURE COMBAT SYSTEM
Multi-Role Resupply – MRR

CRADA w/ UDLP & GD

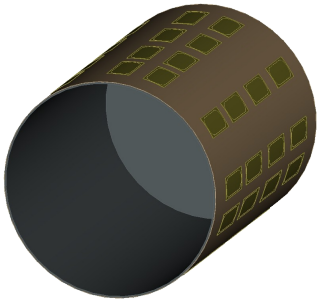
ARDEC teaming with FCS contractors:

- **Bringing ammo packaging knowledge**
- **IM enhancement technologies**
- **Manuever Sustainment concepts**

"Smart Distribution"

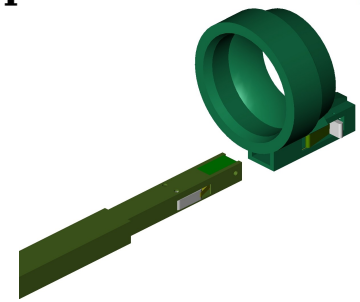


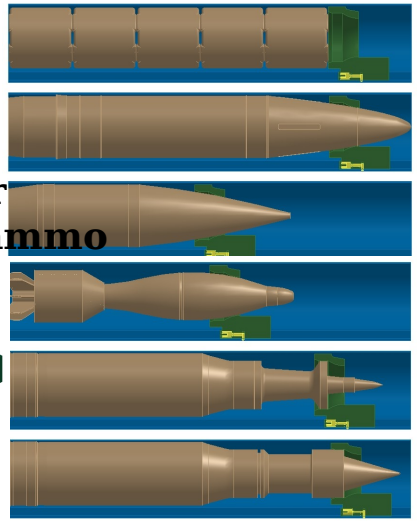
- **JMIC Compliant**
- **Permits FCS Autonomous Re-arm**



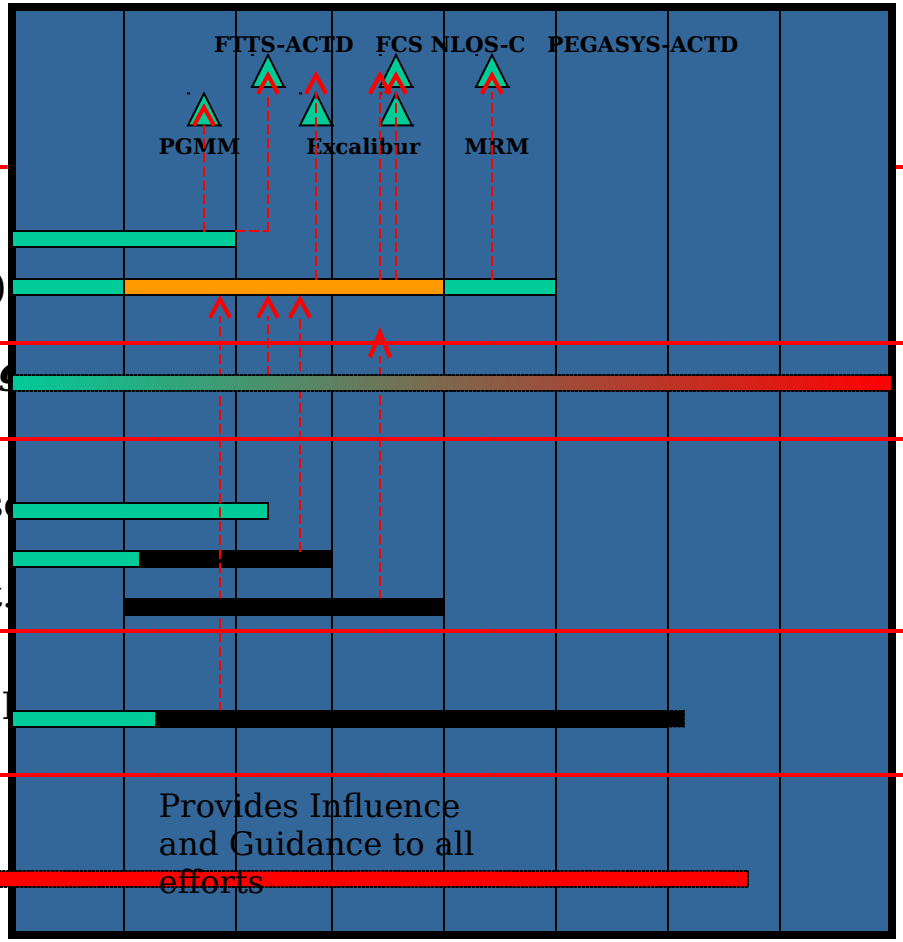
1mm Aluminum Sheet panels attached by rotolining them in place with LDPE(Low Density Polyethylene)

Universal Donut and Vehicle Extractor Bar Compatible with all ammo





FUTURE PACKAGING INITIATIVES – THE PLAN
A Global and Joint Approach



Funding Status
- Funded
- Partially funded
- Not funded
- Unknown

INTEGRATION
Demonstrations
FCS Munitions

-Ammo Provider-
Modular Packaging (Gen 1)
Sustainment Modules (Gen 2)

Gen 1 – Stryker Enabler
Gen 2 –Pallet Module,/ Possible Joint Service

-Improved Munitions Packag

Develops Global and specific Packaging solutions
Ie Enhanced M2A1

SBIR's
Comp. Metal Container (Phas
Modular Pkg (Phase 1,2)
Mod. Interlocking Pallet Cont.

Key feeder enablers for Packaging Programs

CRADA's
UDLP - Multi-Role Resupply (

MRR provides FCS shooters with automated rearm, modularity and IM

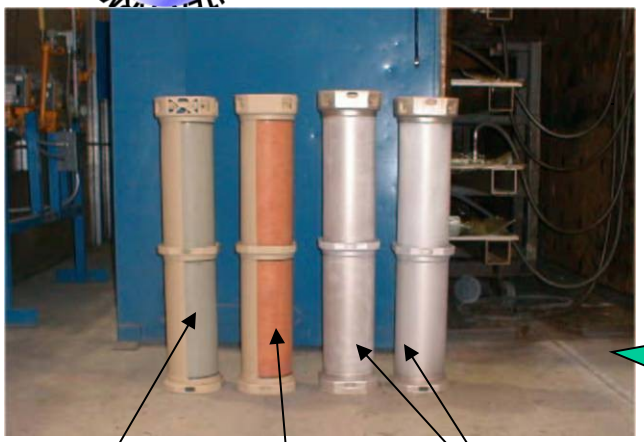
JOINT EFFORT
JILWG*

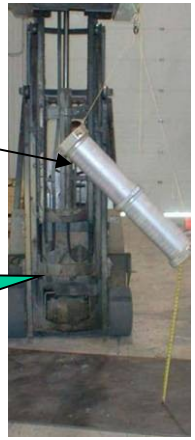
Provides the forum to insure future packaging works with all services and drives commonality and compatibility

* JILWG – Joint Intermodal Logistics Working Group

LIGHTWEIGHT COMPOSITE CONTAINER – SBIR

Enabler for Sustainment Modules





No structural damage from 3’ drop test

Reduce container weight by 25%

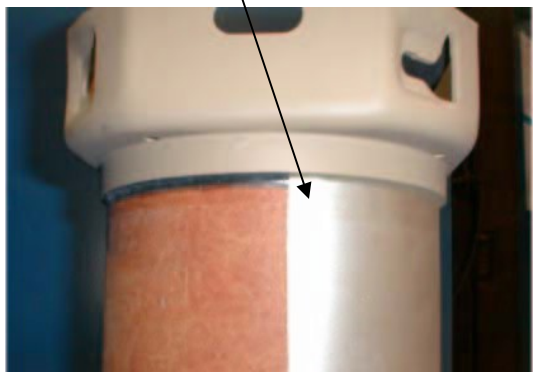
Vinyl Ester Resin

Phenolic Resin

Composite Containers with EMI Coating

Mixing Composite and Metal Components
“The Best of Both Worlds”

Close up of Phenolic resin with EMI Coating

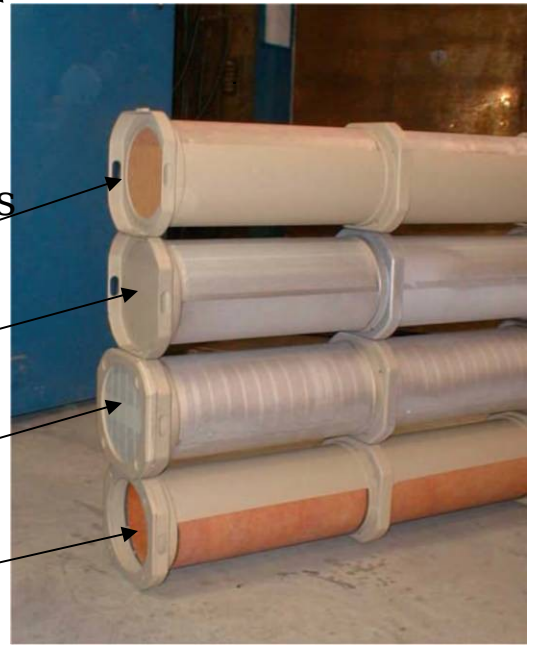


Original Base with MACS Fuse Plate

Original Base

MACS Base with Fuse

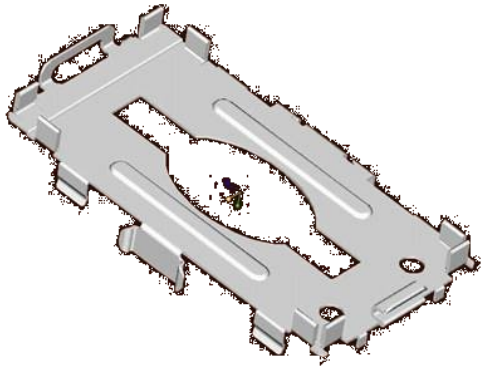
MACS Base without Fuse



LIGHTWEIGHT CONTAINER COMPONENTS
Enabler for Sustainment Modules

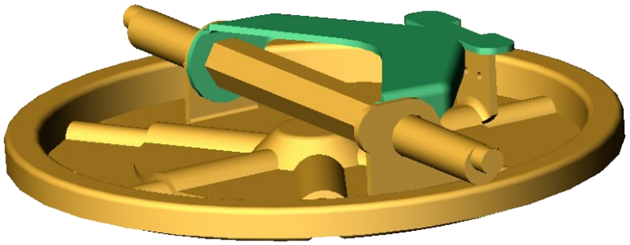
Stacking Aides

Benefits:
External Cushioning
Interlocking – reduced banding



Alternative Cover

Current Design



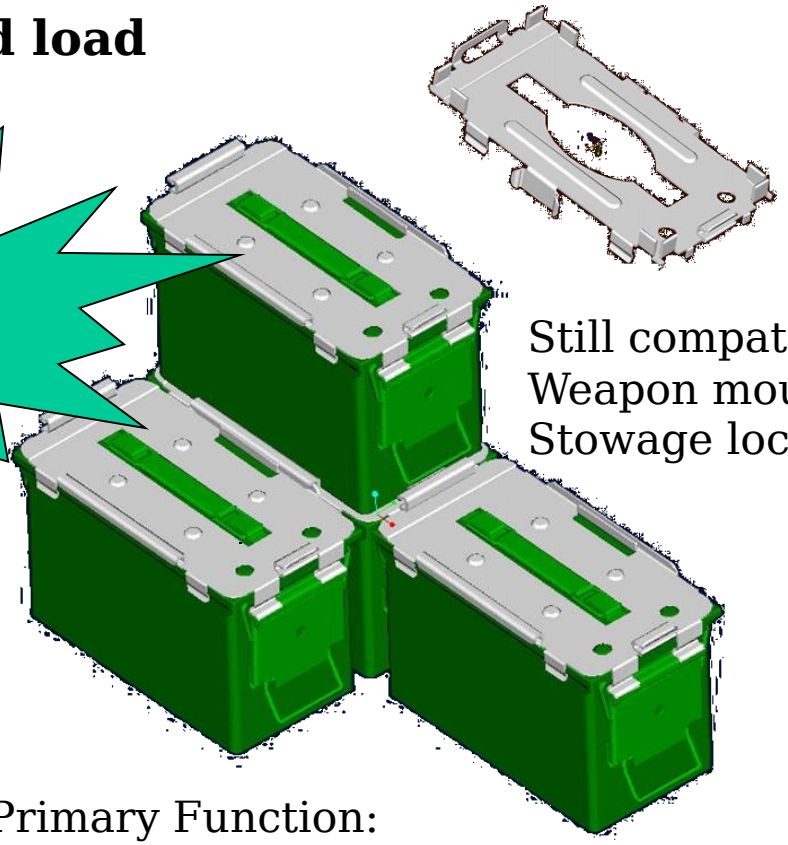
Benefits:
IM Friendly
16% Weight Reduction

New Design

ENHANCED M2A1
Enabler for Sustainment Modules

Goal: Eliminate the Wooden Wirebound Box & provide stabile unitized load

Reduce container weight by 25%



Still compatible with Weapon mounting an Stowage locations

Bulky & heavy.

Not NBC decontaminable.

Excessive time to access ammo.

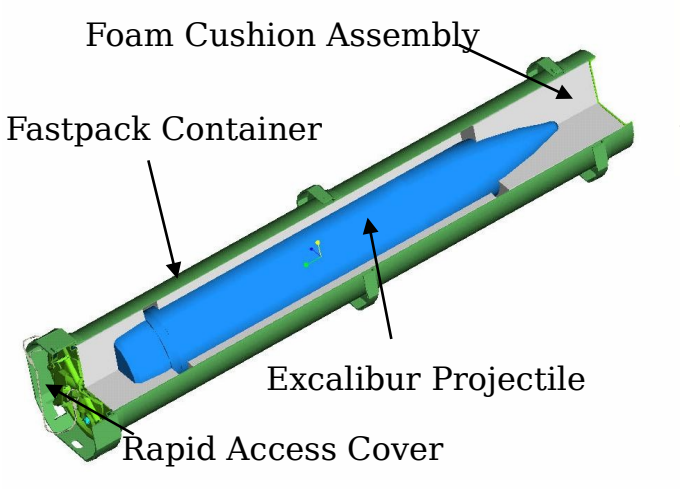
Expensive (~$4.00ea)

Must be Landfilled

Primary Function:

- Front-to-back Interlocking
- Lateral Interlocking
- Inter layer Nesting

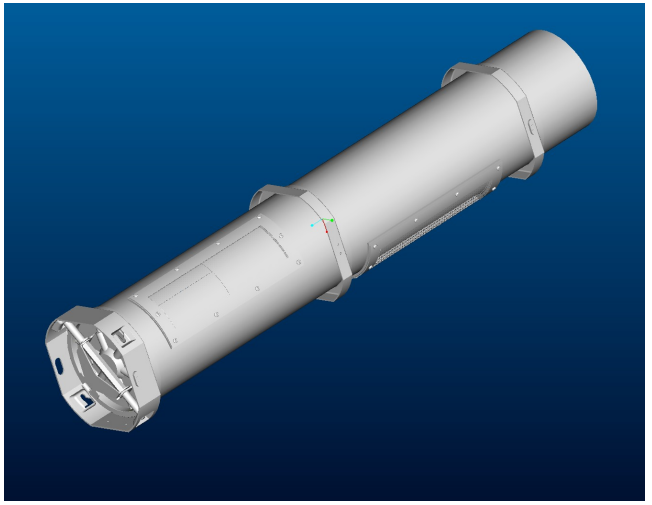
AMMUNITION PACKAGING
Packaging Initiatives - Future



EXCALIBUR
XM982

ARDEC Packaging Design Group was competitively selected by General Dynamics as the package developer for Excalibur

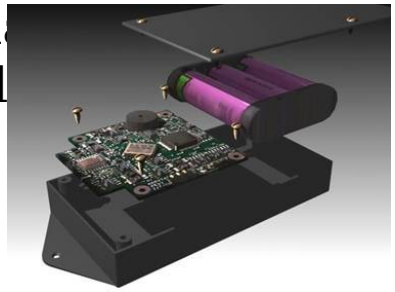
- Welded mild steel tube, formed sheet metal reinforcements in horizontal 4x2 configuration
- Shock absorbent foam inside tube
- Formed assembled end cap recessed, protected
- IM polymer panel design to provide pressure relief during fast cook-off (6 inch panel for warhead and 6 inch panel for base bleed) warhead not exposed
- .375 inch polyethylene sleeve around the warhead to be tested for effect on SD
- Separation of warheads = 2 x .06” steel + 2 x .375 PE + 2 x .625” PE foam + one inch air space between containers



AMMO MARKING AND TRACKING

- ***"2-Dimensional" Barcodes – High Data Capacity***
  - Applied at pallet level and on ammo packaging
  - Significantly improves inventory accuracy and radically reduces time to conduct inventory
  - To be applied on individual FCS ammo in support of automated inven and rearm automation

- ***Remote Readiness Asset Prognostic/Diagnostic System (RRAPDS)***
  - Environmental monitoring sensors and wireless d collection – applied at pallet level (conventional inside missile container or in missile itself



- ***RFID***
  - "Active" (Battery powered "tags") – e.g. SAVI system used on ISO co level for global tracking, also used on air (463L) pallets
  - "Passive" (battery-free) tags – low cost tags – industry striving for the tag
  - LRED has submitted an unfunded program request to RDECOM to se passive tags could be re-engineered for SAFE use in an ammo envi currently they require unsafe levels of power from the reader devic

AMMUNITION PACKAGING Summary

- **Present Ammo Packaging Provides Extreme Protection But Geared Toward a Cold-War Philosophy**
  - Drawbacks:
    - Not IM Friendly
    - Increases Weight Throughout Log System
- **Future Ammunition Packaging Initiatives Strive for Same Protection Levels with Added Benefits:**
  - Aid in Meeting Insensitive Munitions Requirements
  - Facilitate Rapid Air-Delivery and Resupply
  - Integrate with Material Handling/Weapons Systems of the Future
  - Fully Optimized and Compatible within the DoD and Commercial Logistic System
- **The LRED Packaging Design and Engineering Group is Striving to be Leader in Ammo Packaging Innovation.**

AMMUNITION PACKAGING Issues

- Funding for Packaging, Unitization, and Logistics R&D –
  - Tied to Current Production – PEO System

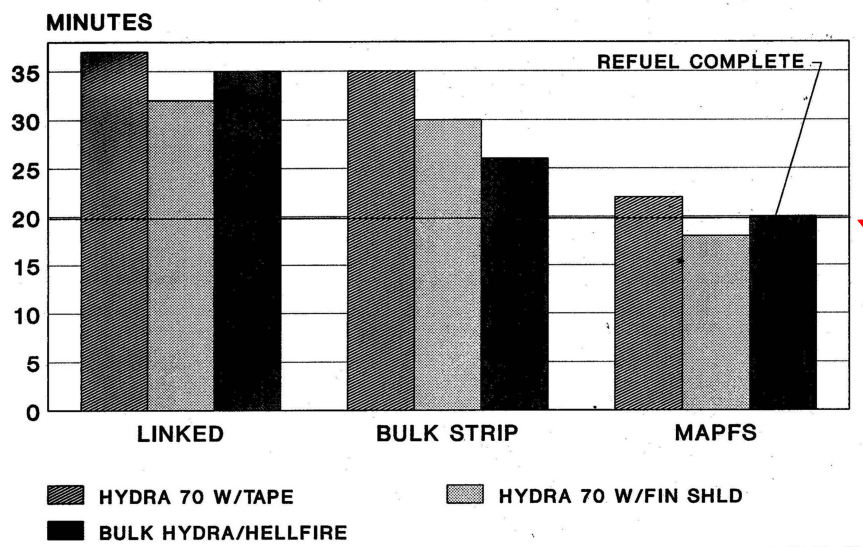
- No Overall Lead/Funding for Logistics Improvements

- Advances in Logistics are Difficult to Implement

RECOMMENDATION:

A Packaging & Logistics Improvement Funding Line be Established Under Authority of SMS IPT Chartered by RDECOM

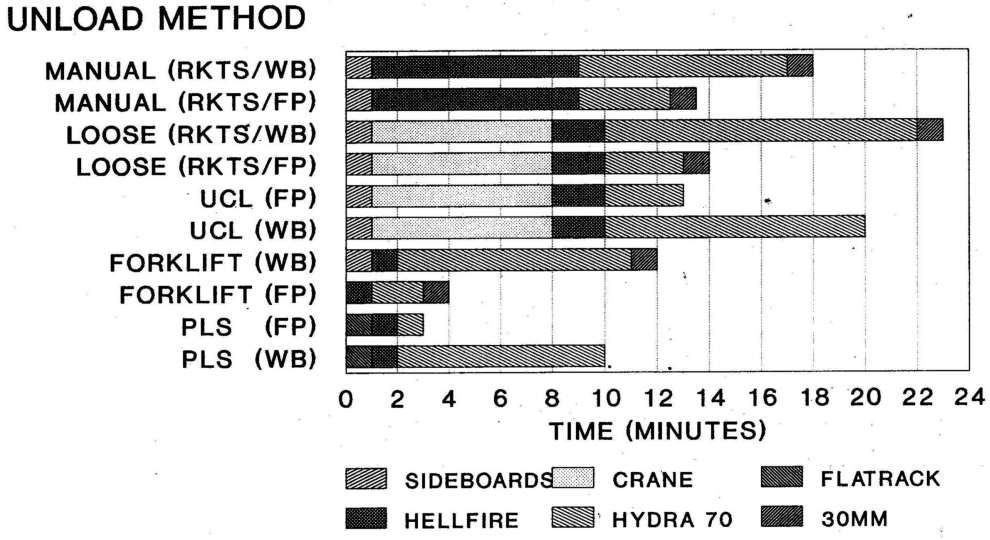
PACKAGING ... A PROVEN COMBAT MULTIPLIER



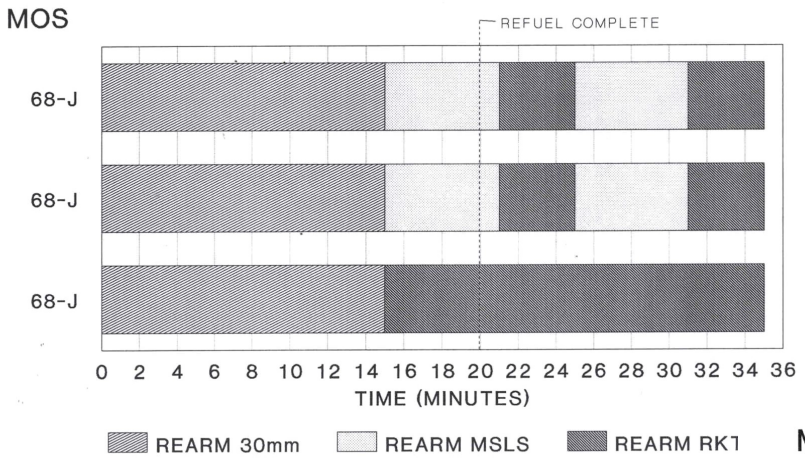
Ammo Packaging Configuration Impacts on Apache Helicopter Rearm Times

20 Minute threshold for FARP Security

Ammo Packaging Configuration Impacts on FARP Set-Up Times



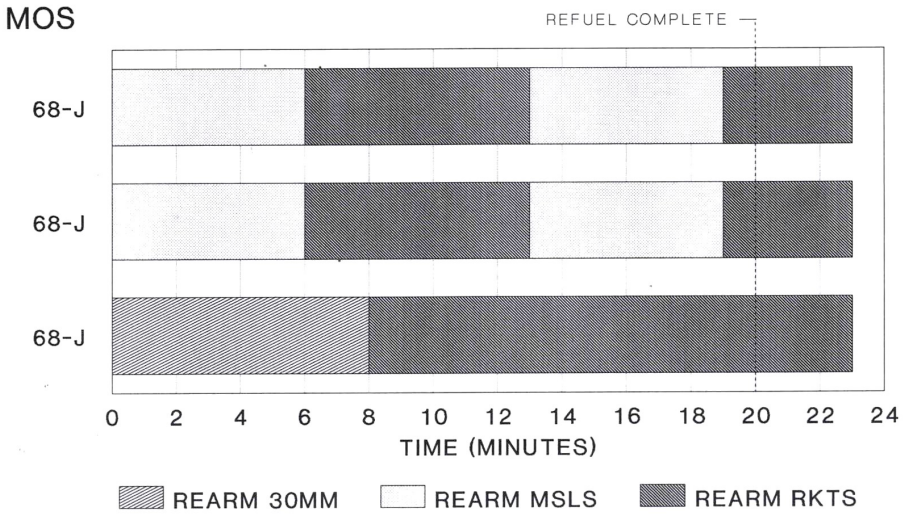
Apache Rearm Analysis



LINKED - 30mm (5 cans, 72 rds ea)

Impact due to:

- 30mm packaging on Bulk Ammo
- Onboard Loader/Downloader



MAPFS - 30mm (3 cans, 110 rds ea)